

## FOREWORD

*Conservationists, Farmers, and Ranchers*

*Farmers and ranchers are becoming more aware of the need for the most effective use of pastureland and rangeland. A major part is having an effective water distribution system. Some field offices staffs may see an increase in workload. This guide will serve as an excellent reference in protecting our natural resources.*

*This handbook is designed to improve your understanding of the planning, design, and installation of livestock watering systems. It will help you learn and understand the basic concepts in water distribution systems and their components.*

*Sincerely,*

A handwritten signature in black ink, reading "Roger A. Hansen". The signature is written in a cursive, flowing style with a large initial "R".

ROGER A. HANSEN  
State Conservationist

Missouri

Livestock Watering Systems

Handbook

January, 1998

## ***DISCLAIMER***

**The mention of products and companies by name does not constitute endorsement by the USDA - NRCS, nor does it imply approval of a product to the exclusion of others that may also be suitable.**

## **NOTE**

We would appreciate the highlighting of any typographical errors or any other discrepancies found. Please send any comments to the Field Technical Services Staff, USDA - Natural Resources Conservation Service, Parkade Center, Suite 250, 601 Business Loop 70 West, Columbia, Missouri 65203.

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### *Acknowledgments*

The handbook is based on the Montana NRCS Stockwater Pipeline Manual. We are grateful to Montana for the majority of the initial work which has been incorporated into our Missouri Handbook.

The material was prepared by work group composed of: **Reese Coulter**, Area Engineer, Hannibal; **Paul Frey**, District Conservationist, Buffalo; **Jeff Gibson**, Civil Engineer, Sedalia; **Dennis Shirk**, Grassland Specialist, Linn; **Curt Walker**, Resource Conservationist, Platte City

Advisors: **Ray Archuleta**, Water Quality Project Manger, Macon and **Richard Koenig**, Head, Design Section, Columbia

Chairpersons: **Maurice Davis**, State Range Conservationist, Moberly and **Neil Pellmann**, Agricultural Engineer, Columbia

Special thanks is extended to commercial product representatives providing product literature for Appendix C in the handbook.

Finally, we especially want to thank **Matt Monton** and **Angie Saunders** of the Field Technical Services Staff and **Ronna Chrisman**, **Susan Spencer** and **Kelly Schweikert** of the Planning and Engineering Staff for their help with this project.

## Pipeline(ft)

### Definition

Pipeline installed for conveying water for livestock or for recreation.

### Scope

This standard applies to pipelines having an inside diameter of less than four inches that are installed for livestock watering or for recreation areas.

### Purpose

To convey water from a source of supply to points of use.

### Conditions where practice applies

Where conveyance of water in a closed conduit is desirable or necessary to conduct water from one point to another, to conserve the supply, or for reasons of sanitation.

### Design Criteria

**Capacity.** For supplying livestock water, the installation shall have a capacity to provide at least 30 gal per day for each 1000 pounds liveweight. This is for dairy and beef cattle, chickens, hogs, sheep, goats, etc.. Other rates may be used as approved by NRCS.

For recreation areas, the capacity shall be adequate for all planned uses of the water, such as drinking, fire protection, showers, flush toilets, and irrigation of landscaped areas.

**Low Pressure Systems.** These systems are operating under low pressures without a pump. The pressure is normally less than 15 psi and length of the pipe is less than 1500 feet. The minimum pipe size shall be 3/4 inch diameter. Flow from spring development may need a larger pipe size. See Chapter 12, Engineering Field Handbook (EFH). Pipe capacities for gravity systems are given in Chapter 12, EFH. Pipe capacity is based on Manning's equation. Low

pressure systems may also be designed based on Hazen-Williams equation like pump pressure systems as shown below. Low pressure pumping systems such as nose pumps, solar pumps, etc., will be considered gravity systems if pressure does not exceed 15 psi.

**Pump Pressure System.** Pump pressure system is any system that has working pressures greater than 15 psi. Pump pressure systems shall be designed by an engineer, approved engineering procedure or a reputable pump pressure system dealer. The design shall meet site conditions. Pipe friction loss per lineal foot shall be based on Hazen-Williams equation as shown in Missouri Livestock Watering Systems Handbook, Chapter 5.

**Sanitary Protection.** If water from the pipeline is likely to be used for human consumption, the requirements of the state health department for materials and installation must be met. Reasonable caution shall be used to ensure the livestock have a safe source of water.

When a pipeline serving livestock is supplied from a utility that provides water for human consumption, an approved method for eliminating backflow will be installed.

**Pipe.** In corrosive soils or waters use plastic pipe. Plastic pipe shall meet the requirements specified in D 2239 or D 3035 for Polyethylene (PE) and D 1785 or D 2241 for polyvinyl chloride (PVC). Equivalent plastic pipe conforming to other ASTM or AWWA Specifications as shown by list in Missouri Livestock Watering Systems Handbook may be used as approved by NRCS.

Galvanized steel pipe is occasionally used for special installations where high strength is required. Steel pipe shall be galvanized and meet the requirements specified in ASTM A 53 or in AWWA Specification C 202.

**Pipe Strength.** To ensure adequate strength, pipe with minimum pressure rating of 150 psi shall be used when burying the pipe or working with systems that operate at over 50 psi. Use a minimum 100 psi rated pipe for above ground

installations. Working pressure of system shall not exceed 72 percent of the pressure rating of the pipe.

**Pipe Protection.** PE pipe for use in above ground systems will be made of materials with 2 percent carbon black to provide ultraviolet resistance. Pipe of this type is suitable for seasonal use. Protect pipe designed for above ground use (freeze resistant pipe) by placement outside perimeter fences and under cross fences, or by shallow burying where soils are suitable. Vegetation should be allowed to grow over the pipe to shade it from the sun. This will keep the water cooler and protect it from the sun. Where fire is to be used as a management tool, specific provisions must be made to protect the pipe from fire.

If cold weather operation is planned, bury the pipe below frost depth or make provisions to drain the pipe. Frost depths are shown in the Missouri Livestock Watering Systems Handbook. Freeze resistant pipe is manufactured to allow expansion of the pipe during periods of cold weather. However, parts of the pipeline, such as float valves, connectors, etc., may not be freeze proof. Install shutoff valves in various locations along the pipeline to allow easy repair of broken appurtenances and damaged pipe.

**Drainage.** Valves or unions can be installed at low points in the pipeline so that the line can be drained as needed. Drainage shall be provided on above ground installations.

**Velocities and Vents.** Velocities shall not exceed 5 fps unless otherwise approved. Provision shall be included in the design for removing air. If parts of the line are above the hydraulic gradient, periodic use of an air pump may be required.

**Joints.** Watertight joints having a strength equal to that of the pipe shall be used. Couplings must be of material compatible with that of the pipe. If they are made of material susceptible to corrosion, provisions must be made to prevent corrosion.

**Vegetation.** Disturbed areas shall be established to vegetation or otherwise stabilized as soon as practicable after construction. Seedbed preparation, seeding, fertilizing, and mulching for all areas over three feet wide will comply with Critical Area Planting (342) standard.

**Visual Resources.** The visual design of pipelines in areas of high public visibility and those in fragile areas shall be carefully considered.

#### **Plans and Specifications.**

Plans and specifications for installing pipelines shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. Construction drawings and specifications will be provided to the landowner.

**NATURAL RESOURCES CONSERVATION SERVICE  
MISSOURI CONSTRUCTION SPECIFICATION**

**FOR**

**PIPELINE AND TANK**

**(516-B)**

**General**

Construction operations shall be carried out in a manner and sequence that erosion and air and water pollution are minimized and held within legal limits.

The completed job shall present a workmanlike appearance and shall conform to the line, grades, and elevations shown on the drawings or as staked in the field.

All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used.

**Materials**

Materials and fabrication shall be as specified on the drawings. Plastic pipe 2 inches or less in diameter meeting ASTM specifications D-1785, D-2239, D-2241 or AWWA C-901 may be used. Plastic pipe over 2 inches in diameter shall be polyvinyl chloride (PVC) 1120 or 1220 conforming to ASTM D-1785 or D-2241. The ASTM or AWWA designation shall be stamped on the pipe. Steel pipe shall meet ASTM specification A-53 or AWWA specification C-202. Other pipe meeting MO-NRCS Pipeline Standard 516 is acceptable.

Tanks shall be durable enough to withstand forces exerted by the water, soil and livestock and shall have a minimum design life of 10 years. Crushed rock or gravel shall be composed of hard durable rock. Poured concrete for pad or tank shall conform to Construction Specification 750, Reinforced Concrete.

**Placement**

Tanks should be placed on suitable subgrade material and face south where possible. The area surrounding the tank should be graded to permit free drainage of surface water.

Tanks shall be located away from dams or critical erosion areas when possible.

Placement of the pipeline shall be as shown on the plans or as staked. The pipe should be free of dirt and other materials before assembling. Flexible plastic pipe shall be placed in a "snake-like" position to provide expansion and contraction with temperature change.

Other parts of the water system shall be installed and connected to the pipeline as specified.

Pipelines shall be placed so that they are protected against hazards imposed by traffic, farm operations, freezing temperatures, or soil cracking. Minimum depth of burial shall be as shown on drawings. Unless otherwise specified, plastic pipe should be buried at least 18 inches for ordinary field traffic. When crossing under a road, it should be buried deeper or otherwise protected from collapsing by placing it in a steel or concrete conduit.

Other means of protection must be provided if the depth required for protection is impractical because of shallow soils over rock or for other reasons. Abrupt changes in grade must be avoided to prevent damage to the pipe.

The pipeline should be buried below frost line or otherwise protected from freezing. If it cannot be protected from freezing, it should be provided with valves properly located so that the pipe can be drained during periods of freezing weather.

Trenches for plastic pipelines shall be free of rocks and other sharp-edged materials, and pipe shall be carefully placed to prevent damage.

Flexible plastic pipelines may be placed by plow-in equipment if soils are suitable and rocks and boulders will not damage the pipe material.

All PVC pipe connections designed to be glued will use PVC solvent cement. Allow glue to cure according to manufacturer's guidelines prior to moving pipe and/or pressure testing. Gluing shall not be done at temperatures below freezing.

### Testing

Pipelines shall be pressure tested by one of the following methods:

1. Before backfilling, the pipe shall be filled with water and tested at design working head or a minimum head of 10 ft., whichever is greater. All leaks shall be repaired and the test shall be repeated before backfilling.

2. Pipelines shall be pressure tested at the working pressure for 2 hours. The allowable leakage shall not be greater than 1 gallon per diameter inch per mile. If the test exceeds this rate, the defect shall be repaired until retests show that the leakage is within the allowable limits, except that all visible leaks shall be repaired.

### Backfilling

All backfilling shall be completed before the line is placed in service. For plastic or

copper pipe, the initial backfill shall be of selected material that is free from rocks or other sharp-edged material that can damage the pipe. Deformation or displacement of the pipe must not occur during backfilling.

Plastic pipelines installed by the plow-in method require surface compaction and shaping in addition to the normal plow-in operations.

Mound soil over pipe to allow for settlement. Provisions shall be provided for stabilizing disturbed areas and controlling erosion, as necessary.

### Pads

When pads are required they will extend at least 2 ft. beyond the tank in front and the sides. Concrete pads should be at least 4 inches thick and gravel pads 10 inches thick. The pad should slope away from the tank.

### Vegetation

Topsoil shall be added, if needed, to establish vegetation. Refer to JS-AGRON-7 for seeding and mulching recommendations or equivalent.

### Additional Details:

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## **PLASTIC PIPE SUITABLE FOR PIPELINE STANDARD 516**

**September 1997**

This applies to pipelines that have an inside diameter of less than 4 inches. Plastic pressure pipe shall be suitable for underground use. The pipe shall conform to the requirements of one of the following ASTM Specifications: The controlling diameter is shown in parenthesis (ID or OD)

- D1785 Polyvinyl Chloride (PVC) Plastic Pipe , Schedules 40, 80 and 120 (ID)
- D2104 Polyethylene (PE) Plastic Pipe, Schedule 40 (ID > nominal)
- D2241 Polyvinyl Chloride (PVC) Plastic Pipe (SDR-PR) (ID)
- D1527 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedule 40 and 80 (ID)
- D2282 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR) (ID)
- D2239 Polyethylene (PE) Plastic Pipe (SDR-PR) (ID) Based on Controlled Inside Diameter (ID > nominal)
- D3035 Polyethylene (PE) Plastic Pipe (SDR-PR), Based on Controlled Outside Diameter (OD)
- D2447 Polyethylene (PE) Plastic Pipe Schedule 40 and 80, Based on Outside Diameter (OD)
- D2737 Polyethylene (PE) Plastic Tubing (ID)
- F771 Polyethylene (PE) Thermoplastic High-Pressure Irrigation Pipeline Systems

or AWWA Specifications:

- C901 Polyethylene (PE) Pressure Pipe and Tubing 1/2 through 3 inch for Water Service (ID > nominal)

Pressure pipe fitting shall conform to the requirements of the appropriate ASTM Specification:

- D2466 Polyvinyl Chloride (PVC) Plastic Pipe Fitting, Schedule 40
- D2467 Socket-Type Polyvinyl Chloride (PVC) Plastic Pipe Fitting, Schedule 80
- D2464 Threaded Polyvinyl Chloride (PVC) Plastic Pipe Fitting, Schedule 80
- D2468 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fitting, Schedule 40
- D2609 Plastic Insert Fitting for Polyethylene (PE) Plastic Pipe
- D3261 Butt Heat Fusion Polyethylene (PE) Plastic Fitting, for Polyethylene (PE) Plastic Pipe and Tubing
- D2672 Bell-End Polyvinyl Chloride (PVC) Pipe
- D2683 Socket-Type Polyethylene Fitting for Outside Diameter-Controlled Polyethylene Pipe and Tubing
- D3139 Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

Solvents-welded pipe joints conform to the appropriate ASTM Specifications:

- D2564 Solvent Cements for Polyvinyl Chloride (PVC) Plastic Pipe and Fittings
- D2235 Solvent Cement for Acrylonitrile- Butadiene-Styrene (ABS) Plastic pipe and Fittings
- D2855 Making Solvent-Cements Joints with Polyvinyl Chloride (PVC) Pipe and Fittings

Rubber gaskets for pipe joints shall conform to the requirements of ASTM Specifications F477, Elastomeric Seals (Gaskets) for joining Plastic Pipe.

Note : ABS Pipe and Fitting may not be available in Missouri. Polybutylene (PB) Pipe and Fittings are no long available.

March 19, 1997

MISSOURI BULLETIN NO. MO-210-7-5

**SUBJECT:** Stockwater Pipeline Manual, Amendment 3

**Purpose:** To correct errors in Amendment 2 for the Hydrostatic Design Stress used to compute strength for plastic pipe. Amendment 2 shall be discarded.

**Expiration Date:** When superseded.

It has been brought to our attention that there is some confusion over the strength of plastic pipe required. The required strength of the pipe needs to be shown on the drawings. As you realize there are many variables when dealing with plastic pipe. Missouri's pipeline standard 516 calls for a minimum pressure class of 150 psi for underground burial and 100 psi for above ground use. This pressure class is rated at a temperature of 73°F. We feel this is the one method of specifying strength that will cover all cases.

Much of the plastic pipe that is normally used for water pipe has a pressure class stamped on the pipe. If not, the pressure class can be computed by the following equation:

$$PC = \frac{2 \times HDS}{DR - 1}$$

PC = Pressure (psi)

HDS = Hydrostatic Design Stress at 73°

DR or SDR = Dimension Ratio or Standard Dimension Ratio

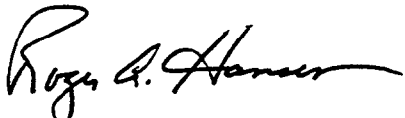
DR =  $\frac{\text{inside diameter}}{\text{wall thickness}}$

SDR =  $\frac{\text{outside diameter}}{\text{wall thickness}}$

The hydrostatic design stress for various plastics are:

<u>Cell Class</u>	<u>Plastic Designation</u>	<u>Hydrostatic Design Stress</u>
for Polyethylene (PE)		
PE 213323C	PE2306 and PE 2406	630 psi
PE 324433C	PE 3406	630 psi
PE 334434C	PE 3408	800 psi
for Poly Vinyl Chloride (PVC)		
PVC 12454-B	PVC 1120	2000 psi
PVC 12454-C	PVC 1220	2000 psi
PVC 14333-D	PVC 2120	2000 psi
PVC 14333-D	PVC 2116	1600 psi
PVC 14333-D	PVC 2112	1250 psi
PVC 14333-D	PVC 2110	1000 psi

Schedule 40 pipe made of PVC 1120 is a common pipe and would meet the 150 psi requirements for plastic pipe 4 inches in diameter and smaller. Further information on pipe diameters and wall thickness can be obtained from the pertinent ASTM or AWWA specification listed in the pipeline manual. If you have any questions, please contact Richard Koenig or Neil Pellman in the State Office at (573) 876-0910.



ROGER A. HANSEN  
State Conservationist

attachments

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